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Fuel Cell Market: A Review

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Abstract

The fuel cell technology is much better than other alternatives because the equipment‘s lifetime costs, including operating costs, are much lower than competing technologies. There are many other benefits that fuel cells provide like low-to-no emissions, lower maintenance costs, high reliability, silent operation, faster fuelling, and constant, high-quality, uninterrupted power. In this paper, we have discussed about the market of fuel cell along with its present need and various obstacles.

Keywords: Fuel Cell, Environmental Sustainability, Fuel Cell Market Share.

I. Introduction

The solid fuels, such as coal and biomass etc. are phased out of the energy market and the today’s prevailing fuels i.e. oil products, are also reducing their share drastically. Hydrogen is one of the few near-zero-emissions energy carriers that could play an important role in future low-carbon energy and transport sectors. Hydrogen can be used as a medium storage for intermittent power sources, allowing for a better exploitation of renewable energy due to their high efficiency. If the fuel cells are fuelled with hydrogen, they can produce great results, as the fuel cells are considered a very efficient means of converting any fuel to energy. So, the fuel cells can play a major role in the transformation towards a more flexible, less vulnerable, distributed energy system which meets energy needs in a cleaner, more efficient and cost-effective way. The energy efficiency and alternative power from fuel cells also play a big role in sustainability. The unfolding of a sustainable fuel cell energy system can bring profound changes to the current energy markets and standard business practices. The emergence of fuel cells can alter fundamentally the structure of the power generation and transportation business, driving to the creation of new products and values, service standards, innovative business partnerships etc. In order to achieve the large-scale transformations, the combination of government measures and business actions is necessary to stimulate the growth of a sustainable fuel cell energy industry.

II. Present market of fuel cells

Few decades ago, the first-generation fuel cells were used in spacecraft for generating power and drinking water, as it is the waste product of fuel cell. But now several types of more-efficient, lower-cost, second-generation fuel cell technologies (e.g., proton exchange membrane, solid oxide, and molten carbonate) are being demonstrated by automakers and utilities in a far broader set of applications [1]. Fuel cells are contributing significantly to energy, economic, and environmental challenges that we are facing today. In the past, the fuel cell market was limited to a few commercial products with high capital cost, but now it is expanding at a high rate. Early market applications include fuel cell power for materials handling equipment, telecommunication towers, data servers, and primary or backup power for retail sites and commercial buildings. The MCFC technology is leading in terms of installations for large stationary applications. In 2005, the total number of large stationary (>10kW) fuel cell installations worldwide was just under 800, of which the MCFC technology achieved the most installations [2]. According to an analysis by Fuel Cell Today indicates that approximately 24,000 fuel cell units (including large and small scale applications) was shipped in 2009, an increase of 41% compared to 2008 [3]. The SOFC technology remains the one of the least developed in terms of number of installations, but it has the largest number of companies actively researching its improvement. Using SOFCs, the company Siemens–Westinghouse built a 100-kW power plant in the Netherlands [4]. Fuel cells for the distributed power market segment can supply power in the range of 3 MW to 100 MW. High temperature fuel cells (MCFCs and SOFCs) are serving this market, which includes traditional utilities, unregulated subsidiaries, municipal utilities, and energy service providers. In future, the fuel cells for this market may be integrated with coal gasification after the year 2015 [5]. By using PAFC technology, the U.S. Company UTC

produced a large number of 200-kW power units and in Japan, multi-megawatt power plants were built. The International Fuel Cell Corporation has developed a commercial fuel cell power plant based on PAFC technology, the PC-25C, a 200 kW, packaged cogeneration system. The advantage of the PC-25C (PAFC technology) is that it is more efficient than PEMFC technology and more suitable for cogeneration [5]. Using PEMFC technology, a marked fraction of power plants were built, which cost more than other fuel cell systems. However, a wider use of PEMFC fuel cells is probably justified in those cases where a cheap source of highly pure hydrogen is available, such as close to chlor-alkali industries, where pure hydrogen is a free by-product [4]. The direct-ethanol fuel cells are developed by many companies. The new-generation direct-ethanol fuel cells are capable of replacing batteries in laptops and similar devices.

Today, most fuel cell–based power plants are produced and set up in the United States due to active government support. In the USA the Energy Research Corporation (ECR) and MC-Power are working on the commercialization. Similarly South Korean government have also achieved 300 such plants operating in 2012 [4]. The European Commission has endorsed the concept of a Hydrogen and Fuel Cell Technology Platform, with the expenditure of €2.8 billion over a period of 10 years in order to reach their target of CO_2 reduction of 60% of current levels by 2050 [6]. The European researchers are more active in the development of residential fuel cell micro-CHP rather than large stationary applications, with about 20% of the world’s operating units (the rest are divided almost equally between the USA and Japan, with the rest of the world also achieving a small share) [7]. In Japan, where in earlier years many large FC-based power plants had been built and operated, but at present the attention is focused on the development of small stationary power plants and on power units for electric vehicles [4]. Many companies like Brandstofel Nederland, Deutsche Aerospace and Ansaldo in Italy, MTU Friedrichshafen, Ishikawajima-Harima Heavy Industries, Hitachi, Mitsubishi Electric Corporation and Toshiba Corporation are using fuel cells on a large scale. Fuel cells for the small commercial market are supplying power in the range of 25 kW to 500 kW. All fuel cell types can serve this market, which includes hotels, schools, small to medium sized hospitals, office buildings, and shopping malls. The higher temperature fuel cells are operating in a cogeneration mode, supplying heat and electricity.

Transportation constitutes indeed a primary target market for both fuel cells and hydrogen. Fuel cells are being used in the transportation sector to power cars, trucks, and buses. Market potential is huge and benefits can be very significant. Major automobile manufacturers, such as Toyota, Honda, and Nissan are planning limited production of fuel cell cars in the future [8]. With a fuel cell and reformer instead of batteries, a fuel cell car will be very much similar to an electric car. They are intended to operate on pure hydrogen, which eliminates the need for an on-board reformer.

Fuel cells are also used for on-site power generation. At present, 8-10% of generated electrical power is lost between the generating station and the user end [8]. So, the fuel cells can be used to produce electricity by relatively small power plants at or near the user end. Fuel cells are highly suitable for on-site power generation, as they do not contribute to smog and they operate very quietly. The stationary fuel cells are currently being used in hospitals, nursing homes, hotels, office buildings, schools, and utility power plants providing primary or backup power.

III. Need of fuel cell for present market

In the last decade, the set of challenges to the energy and transportation markets has broadened, creating market opportunities for fuel cells. The increasing pressure to reduce the environmental impacts of transportation and utility power, and the need to find renewable alternatives to the combustion of coal, natural gas, and petroleum have increased the demand of fuel cells. The fuel cells are becoming cost-competitive with other power-generating technologies in several applications [1]. In the transportation sector, every automaker in the world has a significant fuel cell vehicle development effort since this is the best technology for simultaneously reducing automotive CO_2 emissions and reducing air toxic emissions. The fuel cell technology is much better than other alternatives because the equipment‘s lifetime costs, including operating costs, are much lower than competing technologies. There are many other benefits that fuel cells provide like low-to-no emissions, lower maintenance costs, high reliability, silent operation, faster fuelling, and constant, high-quality, uninterrupted power [9].

IV. Obstacles

At present, there are many obstacles in the path of success of fuel cells. The main problem is the high initial price of fuel cell. Compared to the price of present day energy alternatives like diesel-engine generators and batteries, fuel cells are comparatively expensive. In order to be competitive, fuel cells need to be mass produced and less

expensive developed material should be used in their construction [10]. The infrastructure for the mass-market availability of hydrogen and methanol fuel must also be developed. It is noted that a considerable amount of energy loss occurs in fuel cell operation due to the irreversibility of the electrochemical reduction of oxygen. In order to cure this problem, new catalysts for the oxygen electrodes must be developed. The platinum–metal catalysts generally used in fuel cells are highly active but completely non-selective. They catalyse equally well reactions that are desired and reactions that are not needed or that are even detrimental [4]. So, more advanced highly selective catalysts are needed for the efficient utilization of biofuels in fuel cells for producing electric power.

V. Future Development

The fuel cell is a developing technology just entering the first stages of commercialisation. The current trends indicate that in future, SOFC and MCFC will be important technologies in the large scale stationary energy market while the lower temperature, less fuel-flexible technologies like PEMFC, AFC, and PAFC may be more important at the small-scale end of the stationary market, particularly in residential applications [2].

According to the Business Communications Company, the market for fuel cells was about $218 million in 2000 and reached $7 billion in 2009 [11]. The industry will introduce high-temperature natural gas-fuelled MCFC and SOFC at $1,000 -$1,500 per kW that are capable of 60% efficiency, ultra-low emissions, and 40,000 hour stack life. Fuel cells are being developed for stationary power generation through a partnership of the U.S DOE and the private sector. DOE is also working with industry to test and validate the PEM technology at the 1 kW level and to transfer technology to the Department of Defence in future. It will be used in various sectors to provide energy.

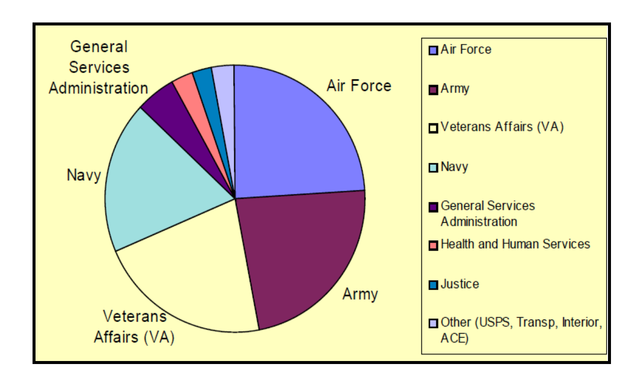


Fig.1: Use of fuel cells in various sectors [12]

According to [9], by the end of the 21st century, mainly hydrogen-based fuel cells and on-site solar photovoltaic installations, hold almost a 50 per cent share of the global electricity market. Electricity co-generation in industrial and residential stationary fuel-cell applications and generation from mobile hydrogen-based fuel cells in the transportation sector (for e.g. fuel cell-powered cars generating electricity while parked) become major contributors to the generation mix, accounting for approximately 38 per cent of the global generation market in 2100.

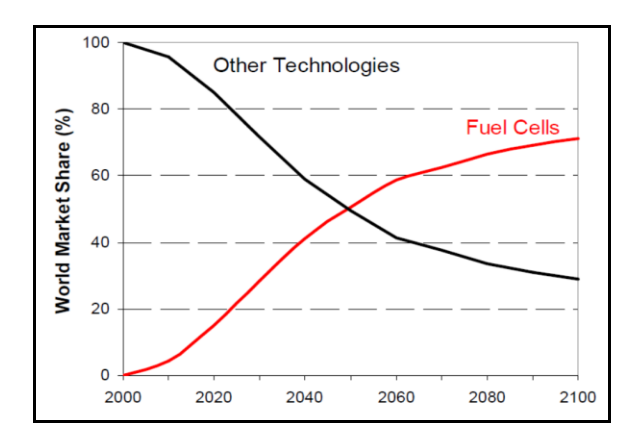


Fig.2: World Market Share of Fuel Cell

The above graph presents the evolution of the market share of fuel cells versus the aggregate of other technologies in the global transportation sector during the 21st century. As it is clear from the graph that the aggregate share of fuel cells will be 51 per cent in the year 2050 and will rise to 71 per cent in 2100 [9]. So, the fuel cells will play a major role in the transportation sector, residential and commercial stationary applications and in industrial sector, to displace the currently prevailing technologies.

VI. Conclusion

The increasing pressure to reduce the environmental impacts of transportation and utility power, and the need to find renewable alternatives to the combustion of coal, natural gas, and petroleum have increased the demand of fuel cells. The fuel cells are becoming cost-competitive with other power-generating technologies in several applications. So, in this paper, we have concluded that fuel cell is very efficient to reduce the pressure which is increasing day by day due to increased consumption of fuel.

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